AS SECTION 3 - ORGANIC 1 - PRACTICE QUESTIONS

1 Trifluoromethane (CHF_3) can be used to make the refrigerant chlorotrifluoromethane ($CClF_3$).

(a) Chlorotrifluoromethane is formed when trifluoromethane reacts with chlorine.

$$CHF_3 + Cl_2 \longrightarrow CClF_3 + HCl$$

The reaction is a free-radical substitution reaction similar to the reaction of methane with chlorine.

(a) (i) Write an equation for each of the following steps in the mechanism for the reaction of CHF_3 with Cl_2

[4 marks]

Initiation step

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First propagation step

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Second propagation step

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Termination step to form hexafluoroethane

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(a) (ii) Give **one** essential condition for this reaction.

[1 mark]

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(b) A small amount of $CClF_3$ with a mass of 2.09×10^{-4} kg escaped from a refrigerator into a room with a volume of 200 m^3. Calculate the number of $CClF_3$ molecules in a volume of 500 cm^3. Assume that the $CClF_3$ molecules are evenly distributed throughout the air in the room. Give your answer to the appropriate number of significant figures.
The Avogadro constant = 6.02×10^{23} mol^{-1}. *(3 marks)*

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2 Some oil-fired heaters use paraffin as a fuel.
One of the compounds in paraffin is the straight-chain alkane, dodecane ($C_{12}H_{26}$).

(a) Give the name of the substance from which paraffin is obtained.
State the name of the process used to obtain paraffin from this substance.
[2 marks]

Substance .....

Process .....

(b) The combustion of dodecane produces several products.

Write an equation for the **incomplete** combustion of dodecane to produce gaseous products only.
[1 mark]

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(c) Oxides of nitrogen are also produced during the combustion of paraffin in air.

(c) (i) Explain how these oxides of nitrogen are formed.
[2 marks]

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(c) (ii) Write an equation to show how nitrogen monoxide in the air is converted into nitrogen dioxide.
[1 mark]

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(c) (iii) Nitric acid (HNO_3) contributes to acidity in rainwater.

Deduce an equation to show how nitrogen dioxide reacts with oxygen and water to form nitric acid.

[1 mark]

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(d) Dodecane ($C_{12}H_{26}$) can be cracked to form other compounds.

(d) (i) Give the general formula for the homologous series that contains dodecane.

[1 mark]

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(d) (ii) Write an equation for the cracking of one molecule of dodecane into equal amounts of two different molecules each containing the same number of carbon atoms.
State the empirical formula of the straight-chain alkane that is formed.
Name the catalyst used in this reaction.

[3 marks]

Equation .....

Empirical formula of alkane .....

Catalyst .....

(d) (iii) Explain why the melting point of dodecane is higher than the melting point of the straight-chain alkane produced by cracking dodecane.

[2 marks]

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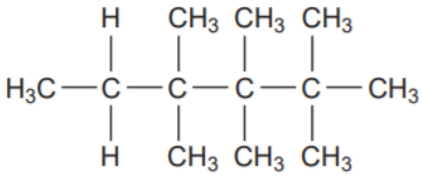
(e) Give the IUPAC name for the following compound and state the type of structural isomerism shown by this compound and dodecane.

[2 marks]



IUPAC name .....

Type of structural isomerism .....

(f) Dodecane can be converted into halododecanes.

Deduce the formula of a substance that could be reacted with dodecane to produce 1-chlorododecane and hydrogen chloride only.

[1 mark]

3 The following table shows the boiling points of some straight-chain alkanes.

	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}
Boiling point / °C	–162	–88	–42	–1	36

(a) State a process used to separate an alkane from a mixture of these alkanes.

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(1 mark)

(b) Both C_3H_8 and C_4H_{10} can be liquefied and used as fuels for camping stoves.

Suggest, with a reason, which of these two fuels is liquefied more easily.

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(1 mark)

(c) Write an equation for the complete combustion of C_4H_{10}

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(1 mark)

(d) Explain why the complete combustion of C_4H_{10} may contribute to environmental problems.

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(1 mark)

(e) Balance the following equation that shows how butane is used to make the compound called maleic anhydride.

$$\text{.....}CH_3CH_2CH_2CH_3 + \text{.....}O_2 \longrightarrow \text{.....}C_2H_2(CO)_2O + \text{.....}H_2O$$

(1 mark)

(f) Ethanethiol (C_2H_5SH), a compound with an unpleasant smell, is added to gas to enable leaks from gas pipes to be more easily detected.

(f) (i) Write an equation for the combustion of ethanethiol to form carbon dioxide, water and sulfur dioxide.

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(1 mark)

(f) (ii) Identify a compound that is used to react with the sulfur dioxide in the products of combustion before they enter the atmosphere.

Give **one** reason why this compound reacts with sulfur dioxide.

Substance .....

Reason .....

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(2 marks)

(f) (iii) Ethanethiol and ethanol molecules have similar shapes.

Explain why ethanol has the higher boiling point.

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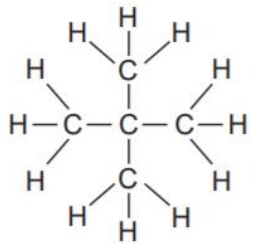
(2 marks)

(g) The following compound **X** is an isomer of pentane.



(g) (i) Give the IUPAC name of **X**.

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(1 mark)

(g) (ii) **X** has a boiling point of 9.5 °C.

Explain why the boiling point of **X** is lower than that of its straight-chain isomer.

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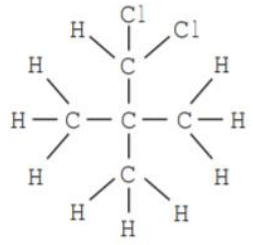
(2 marks)

(g) (iii) The following compound **Y** is produced when **X** reacts with chlorine.



Deduce how many **other** position isomers of **Y** can be formed.
Write the number of **other** position isomers in this box.

(1 mark)

(h) Cracking of one molecule of an alkane **Z** produces one molecule of ethane, one molecule of propene and two molecules of ethene.

(h) (i) Deduce the molecular formula of **Z**.

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(1 mark)

(h) (ii) State the type of cracking that produces a high proportion of ethene and propene. Give the **two** conditions for this cracking process.

Type of cracking .....

Conditions .....

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(2 marks)